Assessing the effects of blockchains in video games: Case IkuneRacers

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Abstract

Blockchain based applications are emerging on many domains to revolutionize software practices. Blockchains utilize technologies such as distributed ledgers and consensus algorithms to provide peer-to-peer based solutions that fulfil benefits like transparency, traceability, and immutability. The purpose of this study was to assess if these beneficial effects could be harnessed in video games to solve issues like poor retention and engagement. Additionally, one topic of interest was to find out if blockchain would affect the way players value their video game assets.

This study utilizes the design science research methodology to address the research problem. One of the steps of the methodology includes creating a design artefact that can fulfil the objectives defined to it. For this study, however, the early steps of the methodology including the creation of the artefact were already done and addressed in a previous paper. Therefore, the main goal of this study is to demonstrate the usage of the artefact with qualitative interviews and evaluate if the objectives have been met. As an additional research question, this study set out to provide suggestions for improving the artefact for a possible new iteration.

The interviews suggested that there were some indications towards increased retention for people who were interested in asset generation or the implementation of blockchain. For engagement, there were signs that people who enjoyed certain kind of video games were engaged by the asset generation aspect of the artefact. These are initial results that should be studied further to get definitive results. For the way users value their asset, there were huge discrepancies that made it difficult to draw conclusions, but the answers provided valuable insight on the topic.

The themes for improving the artefact were the role of authority, asset exchange systems, blockchain transparency, third-party involvement in video games, and trust on blockchain. The findings in this study can be helpful towards further research on any of those topics, but for the purposes of design science research, focusing on asset exchange systems or third-party involvement in video games was established to be most sensible. That is because both of those domains could be improved by new blockchain based designs solutions.

Keywords
Blockchain, video games, DSRM, retention, engagement

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Foreword

Last autumn I participated in a project where the main goal was to create a blockchain-based game. That project works as a foundation that my master's thesis is based on. I want to thank Juho Mattila and Jarkko Tuovinen from Ikune Labs who, as the clients of the project, provided the opportunity to work on this topic. I am also thankful to the members of our project group: Thank you Heikki Mustonen, Jari Paunonen, and Kai Puolakanaho for your teamwork in carrying out the project successfully.

Another one of our objectives during the project was to write a paper where the game, IkuneRacers, could be used as a design artefact. That paper works as the setting that my thesis aims to continue directly from. When writing the paper, our project group collaborated with Iikka Paajala and Pasi Karppinen who are also the supervisors of this thesis. Thank you for your continuous involvement.

Thank you to Leena Arhippainen for reviewing my thesis and providing valuable suggestions for improvement. Last but not least, I am really grateful for everyone who were willing to participate in the interviews.

Jesse Nyyssölä

Oulu, June 10th, 2020

Abbreviations

ABI	Application Binary Interface
ARPU	Average Revenue per User
CMM	Capability Maturity Model
DApp	Decentralized Application
DAU	Daily Active Users
DNS	Domain Name System
DNU	Daily New Users
DSR	Design Science Research
DSRM	Design Science Research Methodology
F2P	Free-to-Play
IDE	Integrated Development Environment
IoT	Internet of Things
IS	Information System
MCF	Mean Cumulative Function
NVT	Network Value-to-Transaction
QR	Quick Response
RPC	Remote Procedure Call
RR	Retention Rate
SDK	Software Development Kit
UTAUT	Universal Theory of Acceptance and Use of Technology

Contents

1. Introduction

Blockchain is a novel technology which has the potential to revolutionize fields from businesses to gaming (Iansiti & Lakhani, 2017; Min, Wang, Guo & Cai, 2019). As a customer-centric technology blockchain provides opportunities for genuine customer engagement (Spyer, 2017). However, Iansiti and Lakhani (2017) pointed out that according to their experience there are technological, governance, organizational, and societal barriers that prevent companies from using innovative technologies. The lack of academic studies on the subject is also noted (Min et al., 2019; Yli-Huumo, Ko, Choi, Park & Smolander, 2016).

The purpose of this study is to assess the effects of blockchain in a mobile game utilizing Design Science Research (DSR). Gregor & Hevner (2013) presented a DSR knowledge contribution framework, where the nature of the contribution is dependent on the maturity of the domain and the solution. The goal of this study is to provide an improvement on the mature domain of video games by using emerging blockchain technologies. This study follows the design science research methodology (DSRM) as presented by Peffers, Tuunanen, Rothenberger & Chatterjee (2007).

The steps of DSRM are (1) problem identification and motivation, (2) definition of the objectives for a solution, (3) design and development, (4) demonstration, (5) evaluation, and (6) communication. This study is based on a research-in-progress paper by Paajala et al. (2020) which I participated writing as a part of the IkuneRacers project work (Figure 1). That paper addresses the first three DSRM steps while this study focuses specifically on the fourth and the fifth step. The communication step happens through this paper and a possible revision by Paajala et al. (2020).

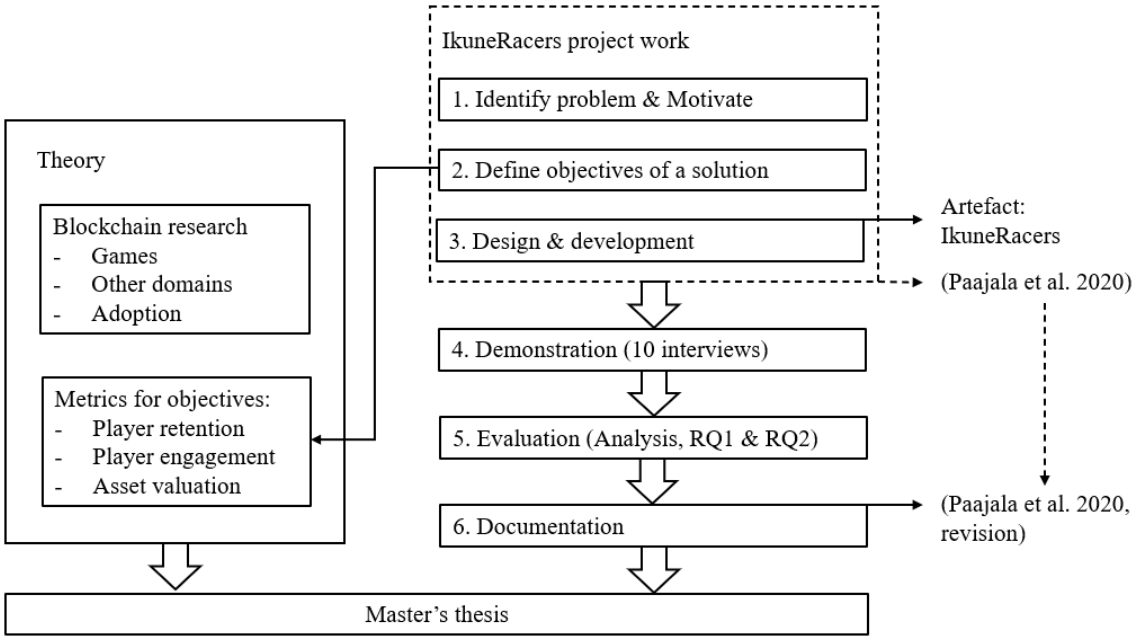

Figure 1. Components of the master's thesis. DSRM model adapted from Peffers et al. (2007).

The role of the IkuneRacers project work is illustrated in Figure 1 along with other components of the master's thesis. This study uses the artefact produced during the project work, IkuneRacers, as the design artefact for demonstration and evaluation. The three most valuable metrics (retention, engagement, and the value of the assets) were also

identified during the project work and established in the paper by Paajala et al. (2020). The artefact and the metrics for objectives were the basis on which the interviews were conducted to assess the effects of blockchain.

The first research question of this study is based on the three metrics and how the usage of blockchain affects them. The second research question aims to explore which blockchain related aspects would be important to consider in a possible later iteration of the artefact.

- RQ1: What kind of effects is the use of blockchain perceived to have regarding user retention, user engagement, and the way users value their assets?
- RQ2: Which blockchain related aspects should be considered for the future iterations of the artefact?

In essence, if the user responds in a way that suggests that the characteristics identified with blockchain have a beneficial effect on the concepts defined in RQ1, it shows that the artefact helps at addressing the objectives as defined in DSRM step 2. If not, it suggests that the artefact should be reiterated before RQ1 can be reliably answered. Due to the scope of this study, I will not be performing additional iterations on the artefact. Rather, RQ1 focuses on assessing the artefact as it is now and RQ2 examines how it could be improved for future iterations.

Although retention, engagement, and the valuation of assets by users are the core topics of this study, the role of RQ2 is to include many other factors as well so that the phenomenon can be assessed as holistically as possible. For example, transparency is almost an abstract concept that affects many parts of blockchain based applications as one of the key blockchain characteristic. At the same time, for example, retention could be affected by a single technological detail, like what kind of exchange system are you using. RQ2 aims to bring all those aspects together.

After this introduction, the thesis starts off by reviewing existing research on the topic in the 2nd chapter. Next, in the 3rd chapter, the research methodology is described in detail to illustrate the theory and practice of what the actual study will consist of. After that, in the chapter 4, the implementation of the empirical study is described, and the findings are presented. In chapter 5 the research questions are discussed along with additional implications of this study. Finally, in the 6^{h} chapter, the thesis is concluded by providing a summary of the results, discussing its limitations, and providing suggestions for future research.

2. Prior research

I will divide the prior research into two categories: blockchain and metrics (retention, engagement, and the valuation of assets). The focal point of this study is blockchain, so it is naturally important to recognize how it is used, where and why. At the same time, it is crucial to identify how do the chosen metrics actually manifest when a user is playing the game.

2.1 Prior research on blockchain

The research on blockchain can further be divided into sub-topics. First, I will present the literature on blockchain and blockchain games in general. The second topic is on the utilization of blockchain on different domains. Lastly, I will showcase some literature on the adoption of blockchain.

2.1.1 Blockchain and blockchain games

Min et al. (2019) provided a statistical view on blockchain games that have been released during the past years. To categorize blockchain-based games, Min et al. (2019) split them into four groups based on the major benefit of blockchains that they utilize: Rule transparency, asset ownership, asset reusability, and user-created content. Meanwhile according to Curran (2019) the main benefits include decentralized asset ownership and exchange, fast and secure payment networks, and ability for developers to monetize their creations. According to Min et al. (2019) the most popular games are rule transparency (i.e. gambling) and asset ownership games (i.e. collecting). However, they note that due to the low amount of playability, asset reusability games can be created to give assets from asset ownership games more value.

On blockchains the ownership of an individual asset can be validated using smart contract standards (Curran, 2019). This adds trust in the system and gives the users confidence to invest in it. Since the tokens are standardized, they can be exchanged between different platforms which is a novel concept that enhances the already lucrative virtual item industry. Curran (2019) notes that developers benefit from blockchains because it helps to reduce the need of intermediaries. What this means is that the developer, or to be more precise, the smart contract created by the developer can be directly accessed by the customer. In addition to the blockchain, this setting does not require any outside infrastructure for the creation of the developer to be accessible. (Curran, 2019.)

Min et al. (2019) provided data analysis that focused on assessing the user and transaction volumes for different kind of decentralized applications (DApps), and the differences between two of the most popular blockchains for DApps: Ethereum and EOS. The main findings are that Ethereum has more users and transactions on trade & investment applications than on games, whereas on EOS has the other way around. Min et al. (2019) attribute this to faster transaction and free gas on EOS. When comparing the transaction volumes and active users on games, EOS leads Ethereum on both noticeably. However, when disregarding gambling and focusing on traditional games, the weekly active users on both EOS and Ethereum was around 20 000 on November 2018. (Min et al., 2019.)

Rossi, Mueller-Bloch, Thatcher, and Beck (2019) assess existing research on blockchains to integrate them and provide a framework for blockchain research in information systems

(IS). In the framework blockchain is divided into protocol level and application level to provide distinction between research on the mechanisms of the blockchain itself and the surrounding environment. Additionally, Rossi et al. (2019) examine the interactions between these two layers. Based on this framework, they provide research agendas for three different fields in IS.

The most relevant agenda for this paper is the "Agenda for Design Science Research on Blockchain". According to Rossi et al. (2019) the most relevant protocol level issues are scalability and environmental sustainability due to the currently used consensus protocols that require a lot of computational power. DSR could provide solutions for a real-world settings that could address these concerns. Regarding the interaction between protocol level and application level, Rossi et al. (2019) suggest that more studies are needed to understand the implications of different protocol design choices used in blockchain applications. What this means for DSR is that different blockchain implementations should be tested in real-world settings and their qualities should be assessed. Finally, on the application level, Rossi et al. (2019) focus on smart contracts. They suggest that the research should consider specifically what happens when smart contracts or related devices are working incorrectly. This is crucial as the data stored in blockchain is immutable, there can be irreversible consequences (Rossi et al., 2019).

Casino, Dasaklis, and Patsakis (2019) conducted a literature review on blockchain-based applications. Although they did not address blockchain games at all, the review described the generic characteristics that blockchain-based applications often share. Casino et al. (2019) provide analysis of attributes that are relevant in blockchain-based systems in comparison to databases:

- lack of trusted third parties,
- immutability,
- multiple non-trusting writers,
- peer-to-peer transactions,
- traceability of transactions,
- verifiability of transactions,
- data/transaction notarization,
- data transparency,
- security,
- privacy,
- maintenance costs,
- rules of engagement,
- need for verifiers, and
- autonomous/dynamic interactions.

Casino et al. (2019) also described common issues that the existing literature addresses. The topics include latency, scalability, sustainability, interoperability, data management, security solutions and big data & artificial intelligence.

2.1.2 Blockchain utilization in other domains

Crosby, Pattanayak and Kalyanaraman (2016) examined blockchain on a general level and the possible use cases the technology could have. The article does this by providing a good basic explanation of the functionality and presents some real-world applications where blockchains are used. The applications are divided into financial and non-financial

applications to further differentiate the possibilities of blockchains from just cryptocurrencies. (Crosby et al., 2016.)

Out of the non-financial applications, the most common utilization of blockchain is to provide a proof of existence (Crosby et al., 2016). Crosby et al. (2016) presented several different notary applications that aim to solve the problem of needing a trusted third party to affirm the existence of a document. The idea is that by storing "cryptographic digest" of a file to a blockchain, the owner can later prove that they had the exact same file at the time it was stored. This method can also provide the proof of integrity and proof of ownership (Crosby et al., 2016).

Other non-financial applications that Crosby et al. (2016) brought up are *Storj* and *Namecoin*. They are blockchain alternatives for traditional server-side solutions. Storj provides an alternative to cloud storage services like Google Drive by having a possibility for people to exchange their disk space for micropayments in the blockchain. Namecoin aims to implement a decentralized domain name system (DNS) to address the fact that current DNS servers are susceptible to censorship or manipulation. These applications, like the notary ones, also depend on public ledgers and cryptographic techniques to ensure that the data on the blockchain is available and immutable. (Crosby et al., 2016.)

Felin and Lakhani (2018) provided an overview of the issues companies can solve using blockchain. The findings they present are based on the utilization of a public ledger and smart contracts. The first solution Felin and Lakhani (2018) presented is *Paying for contributions to intellectual property*. Essentially this means that companies can use smart contracts to automate the management of royalties and rights across industries. The second solution is *Establishing history of ownership* which refers to the ability to make certifications that are distributed and immutable. The third solution is *Making supply chains more efficient and transparent*. Felin and Lakhani (2018) note many positive aspects that a public ledger can provide for a supply chain. The ledgers are inherently transparent which increases trust and can increase efficiency. The updates on the blockchain can be more responsive than on traditional supply chain systems, which gives the possibility to adapt to changes more quickly. This is especially crucial in food industries where food contamination outbreaks need to be addressed as soon as possible. (Felin and Lakhani, 2018.)

Bogner, Chanson, & Meeuw (2016) presented a demonstration of how sharing application could be implemented through Ethereum smart contracts. The principle is similar to Uber or Airbnb, but when implemented as a DApp, there is no longer a need for a trusted third party. The system works through a web application with a graphical user interface that interacts with Ethereum blockchain. Individual objects are encoded as Quick Response (QR) codes and when the renter scans it, they are presented with the rental conditions as laid out by the owner.

The renting procedure by Bogner et al. (2016) is divided according to four smart contract functions. First, the owner creates the object. Then the owner registers it for renting and sets the terms. If the renter has the defined amount to deposit and the object is free, they can then rent it. Finally, the owner can trigger the "reclaimObject" function to assign the object back to him and calculate the final cost of the rent. In addition to the model, Bogner et al. (2016) provided a code snippet for the "rentObject" method to give even more practical understanding of how smart contracts are implemented.

Tonelli, Pinna, Baralla, and Ibba (2018) proposed a model where smart contracts could be used as an implementation of microservices. The idea is smart contracts inherently

share many similarities to the paradigms of microservices. These attributes include clear and well-defined purpose, isolation, and autonomous tasks (Tonelli et al., 2018). To address the operative costs and privacy issues, Tonelli et al. (2018) propose the use of a private Ethereum blockchain.

As an example of their model, Tonelli et al. (2018) presented an E-commerce system which is composed of two layers. In the first layer there is the interface between applications. Specifically, there is an ABI (application binary interface) file that software can use to access correct functions on the blockchain and get the return values in a specified format. The other layer consists of the smart contracts for different areas (account, login, inventory, shipping) in the blockchain that can be accessed with remote procedure calls (RPC). (Tonelli et al., 2018.)

Ramachandran and Krishnamachari (2018) discussed the utilization of blockchain based on three aspects that are relevant for the Internet of Things (IoT). The first is "cryptographic digital signature" which refers to the way blockchains use private keys to generate signatures for transactions which the recipient can verify using the senders public key. The second relevant aspect for IoT is the usage of a distributed ledger, which is based on the idea that every node in the network stores all transaction data or a subset of it (Ramachandran, & Krishnamachari, 2018). This aims to ensure that the data on a blockchain remains immutable. The third aspect as presented by Ramachandran and Krishnamachari (2018) is the usage of consensus algorithms. Since blockchains do not use centralized servers there has to be a way to verify and validate transactions even when there's contradicting elements. Consensus algorithms are there to solve the problem and decide which transactions go through into the distributed ledger. (Ramachandran, & Krishnamachari, 2018.)

Based on the aspects specified above, Ramachandran and Krishnamachari (2018) listed four opportunities that blockchains present for IoT: Privacy/anonymity, monetary exchange of data and compute, record transactions for account and audit, and Smart contracts. Privacy and anonymity are a result of the usage of cryptographic digital signature, and it provides many possibilities for IoT to hide the user's identity in appropriate scenarios. Monetary exchange of data and compute means that community members who contribute to the relevant IoT applications could be monetarily compensated within blockchain. Ramachandran and Krishnamachari (2018) noted that monetary rewards may be essential to involve community members in smart city applications.

Recording transactions for account and audit is inherent in blockchains due to the usage of distributed ledgers. For IoT applications this is crucial because currently the data is often transported through different organizations which can increase distrust of the data (Ramachandran & Krishnamachari, 2018). Smart contracts are another way to improve the IoT related transactions between stakeholders. For example, a sensor owner can create a smart contract that anyone can utilize as long as the payment, as identified in the contract, is fulfilled.

Ramachandran and Krishnamachari (2018) also listed many challenges:

- resource constraints,
- bandwidth requirements,
- security,
- latency demands,
- transaction fees,

- permissioned vs public,
- partition tolerance for intermittently connected devices,
- transaction volumes, and
- physical interface weakness.

In addition to these problems, Chanson, Bogner, Bilgeri, Fleisch, and Wortmann (2019) set out to address the problem of fraudulent data manipulation in blockchain-based IoT systems by developing a sensor data protection system. They used the DSRM to develop a system that would ensure tamper resistance, privacy, sufficient data throughput and economic feasibility. In the end, their work provided both theoretical contribution regarding the design implications as well as practical contributions that address blockchain related issues like privacy. (Chanson et al., 2019.)

Zhang, Walker, White, Schmidt and Lenz (2017a) evaluated what makes a blockchain-based healthcare app feasible and provided metrics for it. The metrics are based on the context of DApps and their current limitations. Perhaps the most essential problem of DApps for healthcare is the security. Since blockchains are public, the data must be encrypted and if possible limited to as small amount as possible. The metric proposed by Zhang et al. (2017a) is that the entire workflow of the DApp should be compliant with "Health Insurance Portability and Accountability Act" used in the USA.

Another question that DApps aim to solve is the interoperability between different systems. Zhang et al. (2017a) presented three levels of interoperability: foundational, structural, and semantic interoperability. In each of these levels, two or more systems can exchange data, but the difference is in how much the receiving system can interpret it. On foundational systems the data is uninterpretable, on structural systems data in structured fields can be interpreted, and on semantic systems all the data can be interpreted with a meaning. The authors insist that DApps should have at least structural interoperability. (Zhang et al., 2017a.)

One issue with centralized systems is that patients rarely have access to their own data and when they do it is system specific and limited. DApps would provide a great technological starting point for patient-centered care. Other metrics that Zhang et al. (2017a) provided for DApps were scalability, cost-effectiveness, and identification.

In another article Zhang, White, Schmidt and Lenz (2017b) remained in the same domain but focused on practical implementation rather than assessing qualities. The authors present four challenges in blockchain-based healthcare apps and then a software design pattern to address each of them. The first challenge is that data on the blockchain cannot be changed later. That is why there must be a way to keep the application evolvable while keeping in mind that it cannot become too complex because the data must be able to be accessed by other systems as well. To address this issue, the authors propose the *Abstract Factory pattern* which provides a uniform interface and modularity. (Zhang et al., 2017b.)

The second challenge is the high amount of storage required if all the data needs to be stored in every node of the network. To solve this Zhang et al. (2017b) proposed a *Flyweight pattern*, which has the basic idea that new contracts are only created if there is not a similar one. To create unique transactions with the Flyweight pattern, the system will combine the common data from the shared contract with the individual identifier of the client.

To address interoperability and security to some extent, Zhang et al. (2017b) presented the *Proxy pattern*. The idea is that the actual important, heavyweight data is on an outside

server and the proxy holds just some meta data and refers to the server. This enables multiple things, for example, editing past records, having additional layer of authentication and simplifies the blockchain-level implementation. On the other hand, it takes out some of the key blockchain characteristics. (Zhang et al., 2017b.)

The last issue by Zhang et al. (2017b) refers to interoperability as well, and to be more precise, to the information flow between departments and systems. To address this, the authors suggested the *Publisher-Subscriber pattern*. In the healthcare system the idea is that publishers keep filtering patient data and when they find something worth notifying, they send a message to the subscribers which, in this case, are related healthcare departments. While it can be implemented through smart contracts, the authors suggest implementing it through application server due to the high transaction costs on blockchains. (Zhang et al., 2017b.)

2.1.3 Blockchain adoption

Schuetz and Venkatesh (2019) presented a blockchain related research agenda based on adoption and financial impacts of blockchain in rural India. In total they provide 11 research questions that are divided into three categories: antecedents, adoption, and impacts. These research questions are laid out in Figure 2.

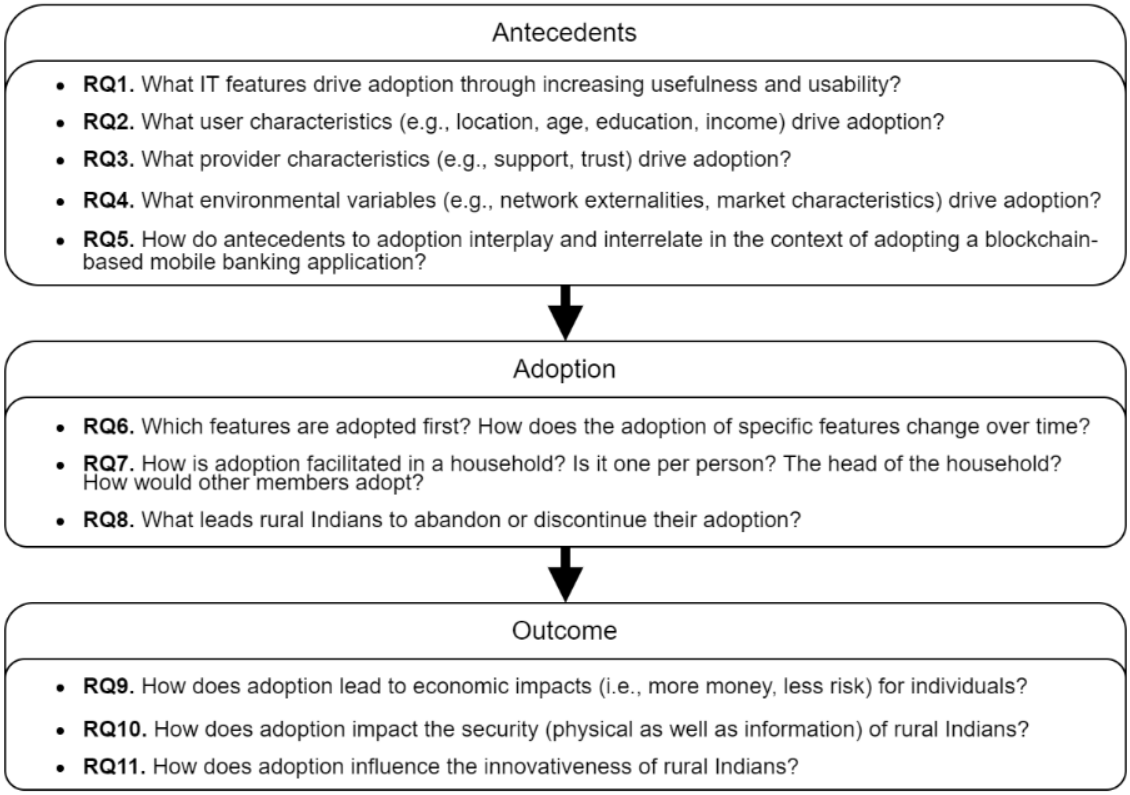

Figure 2. Research questions of blockchain adoption in India. Adapted from Schuetz & Venkatesh (2019).

The antecedents refer to the surrounding factors that exist before the technology is adopted. For example, what kind of users (RQ2) and in what kind of environments (RQ4) is the technology adopted. RQ6, RQ7 and RQ8 examine issues that happen during the adoption process, for example RQ6 aims to identify different stages of adoption. The last

three research questions aim to address what happens after blockchain has been adopted regarding economic impacts, security, and innovativeness.

Wang, Chen, and Xu (2016) provided a brief look into blockchain adoption using the capability maturity model (CMM). CMM divides maturity into five stages (from least to most mature): initial, repeatable, defined, managed, and optimized. Wang et al. (2016) then assess several qualities of blockchain adoption and place them into the maturity model. The least mature aspects of blockchain were *architecture*, *upgrading*, *integration* and *standardization* that were all on the first, initial stage (Wang et al., 2016). Three qualities reached the fourth, managed stage: *Business efficiency*, *data security* and *transaction security*. (Wang et al., 2016.)

Wang et al. (2016) listed conditions for the adoption of blockchain, and if four were fulfilled, they determined that utilizing a blockchain is a feasible choice. The first condition is that multiple participants need to view common information. In the second one multiple participants need to record or change data. Third condition is the requirement of verification and the trust it provides. In the fourth condition central authority needs to be removed to reduce cost or complexity. The fifth requires time-sensitive interactions, and finally the sixth condition mandates that transactions between participants depend on each other. (Wang et al., 2016.)

Queiroz and Wamba (2019) assessed the adoption of blockchain for supply chain management by conducting an empirical survey. Their research model (Figure 3) is based on a modified version of the Unified theory of acceptance and use of technology (UTAUT) model. It also utilizes other literature on technology acceptance models, blockchains, supply chain management and network theories. (Queiroz and Wamba, 2019.)

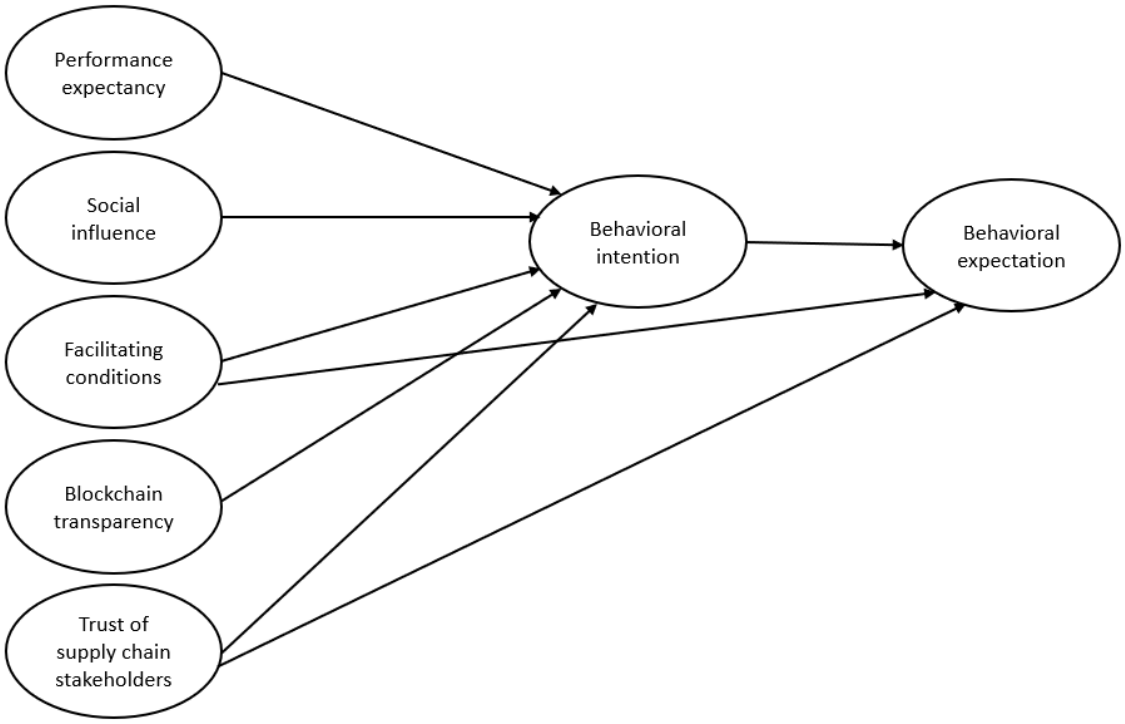

Figure 3. Blockchain adoption research model. Adapted from Queiroz and Wamba (2019).

Figure 3 illustrates the five factors that predict behavioral intention and possibly behavioral expectation as well. Performance expectancy refers to the degree which

system is believed to help at attaining job performance. Social influence increases when an individual perceives that other people believe that the individual should use the system. Facilitating conditions are expected to affect behavioral intention and expectation if the individual believes that there are organization and technical infrastructure to support the system. Queiroz and Wamba (2019) defined blockchain transparency based on how transparency manifests on supply chains. Trust is similarly examined from supply chain management's perspective. However, both trust and transparency are inherent features in blockchains. (Queiroz & Wamba, 2019.)

In their findings Queiroz and Wamba (2019) showcased the results for each factor on both India and the USA. There were some differences between the two countries. For example, social influence had a non-significant effect in the USA while it had a significant positive effect in India. The facilitating conditions factor was, conversely, non-significant in India and positively significant in the USA. Queiroz and Wamba (2019) found out that neither blockchain transparency nor trust of supply chain stakeholders had a significant influence on behavioral intention in India or the USA. The trust had significant influence on behavioral expectation in India, though. (Queiroz & Wamba, 2019.)

2.2 Prior research in the chosen metrics

The research regarding the assessed metrics are divided into three categories: player retention, player engagement and value of the assets.

2.2.1 Player retention

With the large number of data that video games can produce nowadays, Weber, John, Mateas, and Jhala (2011) used game telemetry to assess how different aspects affect player retention in the game *Madden NFL 11*. Game telemetry refers to transmissions of data from the executable for recording and analysis. It can be used both as a service for players as well as internally as a tool to guide development. To analyse the telemetry data Weber et al. (2011) encoded player actions to vectors and used regression models to predict how they affect retention (number of games played).

The first part of the experiment included testing the accuracy of the regression models by comparing the predicted number of games played to the actual number of games played (Weber et al., 2011). Additive regression, the best regression model in their study, gave the correlation coefficient of 0.9. In the second part of the experiment Weber et al. (2011) assessed how different features impact the predicted number of games played. Their main findings were that features *Offensive Play Diversity* and *Defensive Play Diversity* had a negative impact on retention and successful playing performances had a positive impact on retention. Win ratio was noted among the impacting factors, but the optimal win ratio varied based on game mode.

To conclude Weber et al. (2011) gathered the recommendations to improve retention in Madden NFL 11. They suggested to simplify the playbook and present the controls clearly. These suggestions were based on that play diversity reduces success and causes the player to play fewer games. Lastly, they suggested to adjust challenge based on game modes because the optimal win ratio, in terms of retention, can differ.

Drachen et al. (2016) set out to predict player retention in free-to-play (F2P) games using heuristic modelling that can give reasonable predictions from short-term data. In the study

Drachen et al. (2016) analysed a dataset of 130000 players from the game *Jelly Splash*. The idea was to analyse the activities from the first game session to the seventh day after that to determine whether the player was retained or churned on the second week. The whole 1-7 days feature window managed to reach the prediction accuracy of 0.786, while predictions based on just the first session had accuracy of 0.613. (Drachen et al., 2016.)

The assessment of feature importance by Drachen et al. (2016) showcased which aspects had the largest impact on player retention. The key findings were that the strongest positive predictors of retention were Total Rounds, Total Sessions, and Average Duration, whereas the most negative were Current Absence Time, Average Stars, and Average Time Between Sessions (Drachen et al., 2016). In essence, if the player has been playing the game, they will likely play it again. The negative impact of high number of average stars and the low number of average moves tells that some players have clearly left after finding the starter levels too easy (Drachen et al., 2016). Regarding seemingly easy repetitive tasks Lovato (2015) notes that "grinding" offers a concrete and quantifiable series of material rewards for the player, but it is not enough to make the game great. For games like *World of Warcraft* and *Diablo 3*, Lovato (2015) noted that grinding is there just to reinforce the core gameplay of otherwise polished games.

In the end Drachen et al. (2016) addressed the issue of identifying long-term users. Long-term players are generally considered high-value players due to bringing in a disproportionate amount of revenue. The model by Drachen et al. (2016) could not make a notable distinction between players that are expected to play between the days 8-14 and 60-67. Since there are a lot of games that are designed to be played every day they inherently punish for inactivity. Lovato (2015) suggested to solve this issue, with the example of rewarding players for coming back after long absence.

Viljanen, Airola, Majanoja, Heikkonen, and Pahikkala (2017) introduced mean cumulative function as a tool to illustrate and estimate various metrics, including number of game sessions and purchases. With the data from a game called *Hipster Sheep* Viljanen et al. (2017) first review the current approach of measuring retention and monetization and then present their approach utilizing mean cumulative function (MCF).

Some of the popular metrics that are currently used to assess retention and monetization include daily new users (DNU), daily active users (DAU), retention rate (RR) and average revenue per user (ARPU) (Viljanen et al., 2017). Although RR is typically calculated by dividing the number of active unique players on a given day by the total number of players in that cohort, Viljanen et al. (2017) provided an example of calculating RR based on sessions per day. They present a table where each day gets a new cohort (DNU) and they map the number of sessions each cohort plays on the following days. Then to calculate the session-based RR, you just need to divide the number of sessions on a given day by the number of players in the cohort. For example, one cohort that Viljanen et al. (2017) presented has the retention rates 1d to 5d (from the first day to the fifth) of 1.7, 1.0, 0.5, 0.4 and 0.2.

Viljanen et al. (2017) provided plenty of mathematical functions and definitions regarding the calculations of their MCF approach, but they are not relevant for this paper. Their research analysis, however, provided some insight on why MCF can help when assessing the retention data. For example, an update on Hipster Sheep caused the number of sessions during the first month to decrease compared to the old version, but on later months the session counts were notably higher. To decide which one is better, MCF fits perfectly as it shows exactly the point where the cumulative values of the new version surpass the values of the old version. (Viljanen et al., 2017.)

Another benefit of MCF is that as a cumulative metric it smooths out the noise when used with limited data sets (Viljanen et al., 2017). As an example of this, a simple test was conducted where 1800 players were divided into three cohorts that had different progression speeds in the game (normal, faster, fastest). With a small sample size, the traditional metrics are very sensitive to noise and it is hard to make conclusions visually. The MCF plot on the other hand showcases how the "faster"-cohort stays above the rest consistently. (Viljanen et al., 2017.)

2.2.2 Player engagement

Przybylski, Rigby, and Ryan (2010) presented an empirical model for evaluating the process of how video games motivate sustained engagement and how do they affect the player's well-being. First the motivation to play the game is divided into intrinsic (for the game itself) and extrinsic motivation (for external reasons, like rewards or punishments). Out of these two, intrinsic reasons cause more enjoyment and other positive effects, so it is main focus of the paper. (Przybylski et al., 2010.)

Intrinsic motivation can further be divided into three human needs: *competence*, *autonomy*, and *relatedness* (Przybylski et al., 2010). In games the need for competence is satisfied through challenges and goals that the player undertakes. The need for autonomy is met by giving the player flexible choices, varying goals, and new environments. To satisfy relatedness games can provide the player social interactions and communities through online features, for example. Related to the game motivation Przybylski et al. (2010) note that it is necessary for the player to have mastery of controls for achieving need-satisfying play, although it is not satisfying in itself.

Przybylski et al. (2010) used these three forms of need satisfaction to examine various forms of player behaviour. For example, their review showed that when compared to need satisfaction, violence was not a reliable motivator for playing a game nor did it add appeal for the game. Another thing that the review showed was that the cause for people to be obsessively engaged in video games is likely due to the lack of need satisfaction in their day-to-day lives. In essence, one is not deprived because of playing video games obsessively, but they play video games because of being deprived. (Przybylski et al., 2010.)

In the end Przybylski et al. (2010) summarized the results with regression models. The main findings are that all three needs (competence, autonomy, relatedness) are positively linked to game enjoyment and future play. On top of that, competence and autonomy predict well-being, while competence and relatedness lead to weekly play. Przybylski et al. (2010) claimed that the motivational processes based on these needs are better predictors of player behaviour than player demographics, and they apply across genres.

Bouvier, Lavoué, and Sehaba (2014) noted the interest in engagement in many domains including marketing, communications, digital games, virtual reality, and education. However, many of the domains have different views of what engagement means and on top of that there are multiple terms for overlapping concepts. Bouvier et al. (2014) examined the terms *attention, immersion, involvement, presence,* and *flow* to describe their views on engagement.

In the model by Bouvier et al. (2014) immersion and involvement form the media factor. Together with content factor (the game scenario itself), the game encourages the players to shift their attention from the real world into the game world. When this happens, the

factors have matched the player's expectations and the player suspended their disbelief. Although the player's attention is towards the game content, their consciousness is still directed to the real world. According to Bouvier et al. (2014) this is the state of engagement. When the player's consciousness shifts into the game world as well, the player gets the feeling of presence. Flow is the action-oriented part of presence. (Bouvier et al., 2014.)

Bouvier et al. (2014) based the motivational factors to the same Self-Determination Theory (SDT) that Przybylski et al. (2010) used, to identify the three basic needs: competence, autonomy, and relatedness. Together with their definition of engagement and the SDT, Bouvier et al. (2014) identify four types of engaged behaviour. These are summarized in the Table 1.

Table 1. Examples of players' needs, emotions, and behaviour according to the type of engaged behaviour from Bouvier, Lavoué, & Sehaba, (2014).

	Environmental engagement	Social engagement	Self-engagement	Action engagement
SDT basic psychological needs	Autonomy towards the environment	Relatedness	Autonomy towards the character	Competence Autonomy towards the actions
Elicited emotions	Escapism Curiosity Surprise Imagination Relaxation Aestheticism	Pleasure in social connectivity Collaboration Competition Social recognition	Pleasure in possessing or managing an avatar Pleasure in disguising themselves	Accomplishment Self-esteem Arousal
Player behavior	Contemplative Curious Exploration Modding	Expanding social network Livening up the group of actual friends Sharing moments with others	Customizing the character Developing a story around the character	Mastering the game Completing a challenge Practicing Elaborating a strategy

Table 1 showcases the four types of engagement in relation to player needs, emotions and behaviour. For example, it shows what kind of emotions are associated with social engagement: Pleasure in social connectivity, collaboration, competition, and social recognition.

2.2.3 Asset valuation

There are several frameworks to assess the value of crypto assets (Lannquist, 2018; Bheemaiah & Collomb, 2018). Bheemaiah and Collomb (2018) describes *Store of Value* method as one of the first and a very simplistic valuation method. The main idea in Store of Value is that currencies that have stable number of units can only hold or grow their value. The value of a single asset is then the total value of all assets behind the currency divided by the number of assets. However, as Lannquist (2018) noted, fiat currencies do not have any intrinsic utility and their value is ultimately based on acceptance, belief and confidence.

Token velocity methodology is based on *The Monetary Equation of Exchange*: MV=PQ. In blockchain asset valuation the implication of the equation is that when the velocity (V)

lowers, the token price (M) will increase (Lannquist, 2018). The equation requires too much assumptions and the individual variables are hard to determine accurately, so Bheemaiah and Collomb (2018) described it as a tautology rather than a formula.

The J-Curve methodology comes from the curve of a price of a cryptoasset over time. The initial rise comes from the expectations of early adopters. The value then drops, but over time, the expectations catch up again and the price begins to grow. Bheemaiah and Collomb (2018) noted that although J-Curve is often used to calculate the period when investment becomes profitable, it is more a life cycle model of product development than an asset valuation method.

Network Value-to-Transaction Ratio (NVT) is valuation method that is based on comparing the network value to the daily transaction volume (Lannquist, 2018; Bheemaiah & Collomb, 2018). By dividing the network value with the transaction volume, you get some ratio. By comparing this ratio to others, you can determine if the token is under- or overvalued (Lannquist, 2018). Bheemaiah and Collomb (2018) noted that there is a reflexive relationship between these two factors. For example, if the value of an asset rises, users might be tempted to sit on those assets, which in turn reduces transactions.

3. Research methods

In this chapter I will describe the utilization of the design science research methodology (DSRM) framework by Peffers et al. (2007) in detail. After the general theory, I will present the DSRM steps that are relevant for this study. This chapter also includes information about the artefact and the interview methods that will be utilized.

3.1 The DSRM framework

The DSRM framework by Peffers et al. (2007) is a methodology intended for the production and presentation of design science in the field of information systems. Hevner and Chatterjee (2010) described the method as a contribution to IS research that provides a commonly accepted framework for DSR and a mental model for its presentation. The DSRM process model includes six steps.

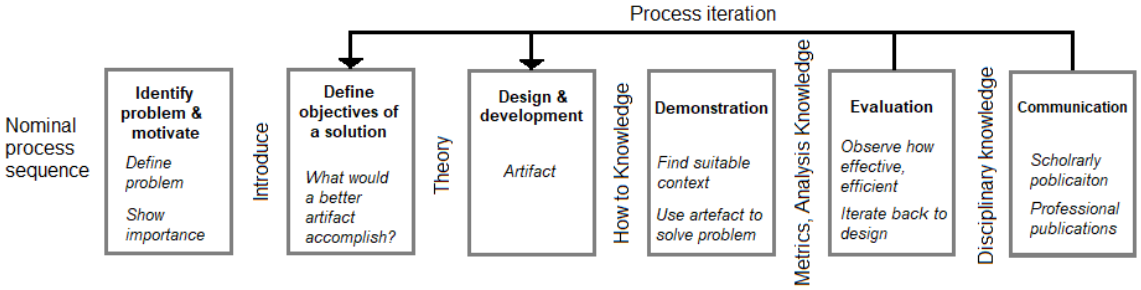

Figure 4. Design Science Research Methodology (DSRM) Process Model. Adapted from Peffers et al. (2007).

Figure 4 illustrates the sequence of the steps in the DSRM as well as possible process iteration points and possible research entry points. The process sequence starts by identifying the problem and motivating both the researcher and the audience to pursue for a solution. Peffers et al. (2007) noted that breaking the problem into smaller parts can help at conceptualizing the complexity of the problem. In the second step, the problem definition and knowledge on the topic are used to formulate concrete objectives for the solution. In the third part of the process, the objectives are used as a basis for design and development of the artefact. According to Peffers et al. (2007) artefacts can be constructs, models, methods, instantiations or "*new properties of technical, social, and/or informational resources*".

The next two steps are closely tied to each other. First in the demonstration step, the artefact is utilized in an appropriate context. Then in the evaluation step, the observed results of demonstration are compared to its objectives. Peffers et al. (2007) noted that the objectives can be those identified in step 2, but also things like objective performance measures, surveys, or simulations. Finally, in the 6th step, communication, the resulting knowledge is diffused to researches and relevant audiences. This can be done with formats such as the DSRM itself. (Peffers et al., 2007.)

3.2 The DSRM steps of past and future

Most blockchain related studies are on Bitcoin, while the research on blockchain based applications and games remains still scarce (Yli-Huumo et al., 2016). The potential of

utilizing blockchain in games has been recognized, however (Curran, 2019). Paajala et al. (2020) therefore define the initial problem as the lack of blockchain applications and research on benefits of blockchain in games.

The objective of this study is to determine what kind of effects does blockchain have on mobile games. The requirement for that is determining the metric itself and a way to measure it. Paajala et al. (2020) established retention, engagement, and the value of the assets as the three most suitable metrics for objectives. Despite the using the same metrics, it should be noted that this thesis is independent from the work by Paajala et al. (2020). What it means is that the relevant topics are examined based on the prior research as presented in this paper.

The third step of the DSRM process is the design and development of artefact. This study will use the artefact that the project group developed during the project work: IkuneRacers. The same artefact is also described in the paper by Paajala et al. (2020). The design and development process is described further in the chapter 3.3.

The main focus of the DSRM steps for this paper are demonstration and evaluation. The implementation of these steps will differ slightly from the plans by Paajala et al. (2020) which included several metrics that utilized quantitative game data collected straight from the application. However, since these tools have not been implemented in this iteration of the artefact, I will only use interviews as a data gathering method. This means, for example, that there is no absolute numbers of retention from players, but the retention has to be assessed based on the answers given in the interviews.

In terms of DSRM steps, what I will do is demonstrate the use of artefact with interviews and then evaluate them. The evaluation is based on how well the blockchain related effects, as described in the literature, are reflected in the experiences of the interviewees. The methods of conducting the interview and analysing the results are explained in The Interview chapter. For the DSRM process model the evaluation stage is important because it defines the issues that the artefact can be iterated on.

3.3 The Artefact: IkuneRacers

For the artefact, our project group created a blockchain-based mobile multiplayer game with Unity. The game is a turn-based racing game, where players tap their cars for them to move forward. Although there is not much in terms of gameplay in the game currently, the idea is that by having the cars, including their attributes like name, colour and speed, as blockchain items, the game can illustrate the beneficial effects that blockchain can bring. In the current version of the game, players get coins from participating in races and these coins can be used to generate more cars.

Figure 5. Gameplay screenshot taken from the mobile version.

Figure 5 showcases the gameplay screen of the game as seen in the client created with Unity. Names of the racers are randomly generated in Unity and actually work as a seed that the blockchain uses to calculate attributes for the racer object. The speed value of the car consists of three dice related attributes which are represented in the format "xDy+z". Here x refers to the number of dice that are thrown, y is the number of faces in the die, and z is a constant modifier added to each result. To determine how much a racer moves for each tap the rolling of the dice is simulated and indicated at the lower part of Figure 5. All relevant attributes for the game can also be seen on a Garage page (Figure 6).

Figure 6. Racers as seen on the garage page (PC screenshot).

In addition to the dice values, the blockchain stores several values, like the racer's level, its model and color, and the races it has participated. Although the model and color are stored as values on the blockchain, in the game they are presented visually. In the garage

page (Figure 6), this means rotating a model of the car next to the name while other values are listed in a table.

To implement the blockchain our project group used Loom as a platform. It is meant for decentralized applications and includes a software development kit (SDK) which streamlined our development process. Loom is based on Ethereum, but it is designed to be more responsive and therefore fits well for our purposes. For our project, we did not use neither the Ethereum mainnet or the Loom mainnet because they require tokens that have real-world value. Instead, we used the testnet provided by Loom called Extdev which is free for development purposes and has the same functionality as the mainnet.

The functionality of the blockchain is based on smart contracts. They are written in a language called Solidity and built and deployed with a tool called Truffle. In essence the smart contracts define a way the data is stored in the blockchain and the functions of how it can be managed. Since smart contracts are a relatively novel technology, most development environments or text editors do not support Solidity's syntax yet. This is why we had to use Visual Studio Code (text editor) with an extension called "solidity" while in Unity development we used Visual Studio 2019 (Integrated development environment).

In order to retrieve the relevant data from the blockchain, a reflective set of functions has to be implemented on Unity as well. Loom's SDK enabled us to implement the queries to the blockchain as if they were built locally given that the correct blockchain and contract is specified in the application. The following sequence diagram showcases the interactions between the user interface (Lobby Panel), the blockchain handler in the Unity game (Blockchain Client) and the actual smart contract within the blockchain (AccountContract).

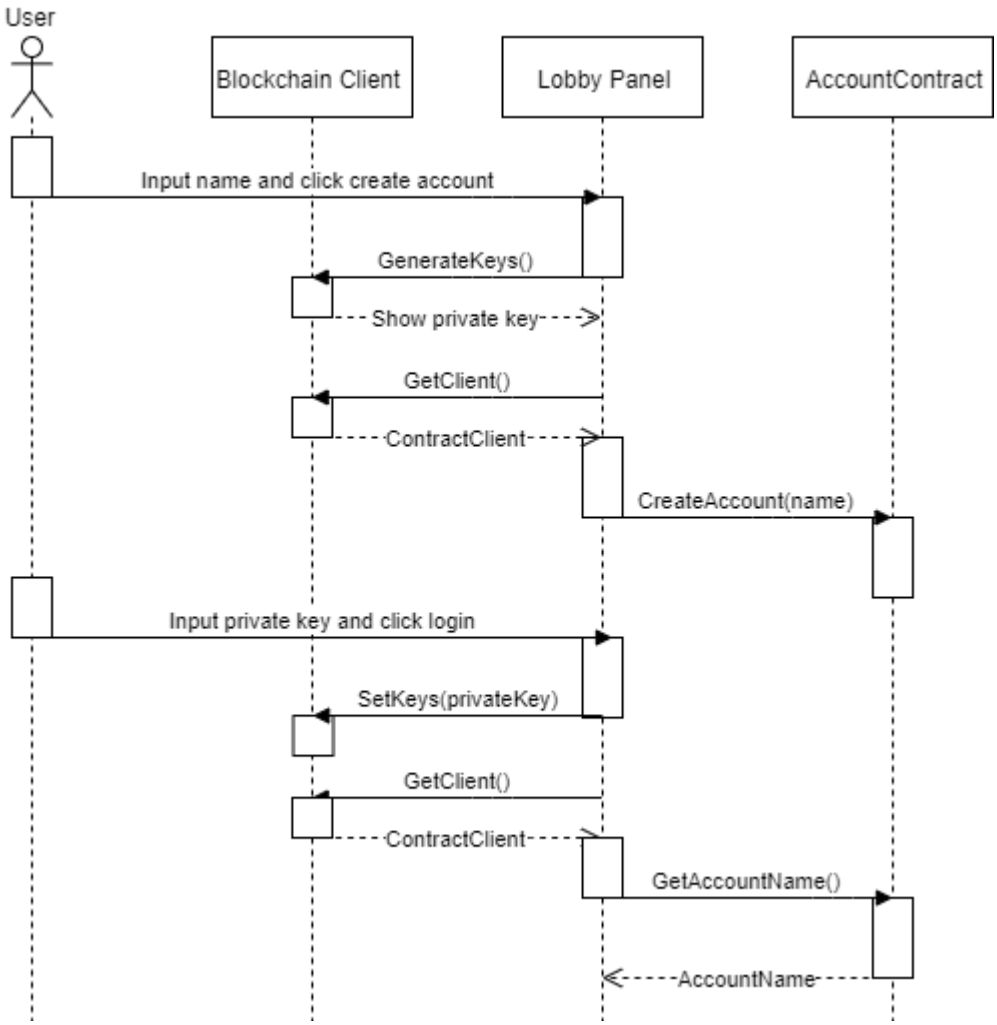

Figure 7. Sequence diagram of creating an account and logging in.

In figure 7 it is important to know that the account is not identified based on the name; it is based on the private key. That is why when first creating the account "GenerateKeys()"-function is called and when logging in, the blockchain client will use user input. Based on this key, the client will use a hash function to calculate its address that the blockchain will use to identify the user. This is illustrated in the last exchange of figure 7, where the function "GetAccountName()" is be called without parameters as the contract knows who is calling based on the address.

The racers in the blockchain are also stored based on the addresses of the owner. To be more precise, every address corresponds to an array of IDs and a certain ID corresponds to the position it is in an array of all the racers. This way the client can retrieve all their racers without any parameters at all.

3.4 Interviews

The interviews will consist of playing the game, possible briefing on blockchain, and asking the interview questions. In this chapter the theory that the interview will be based on is presented and after that the practical considerations regarding the interviews in this study are explained in more detail. This chapter concludes with a description of the data analysis method used on the interview results.

3.4.1 The interview method

The interview will follow the method by Schultze and Avital (2011) to guide the interview to generate appropriate data for this study. Before explaining the method, they begin by explaining what it means to have "rich data". Then Schultze and Avital (2011) assess different perspectives regarding scientific interviews, and finally they suggest three scientific interviewing methods that can be used for IS research. (Schultze & Avital, 2011.)

Schultze and Avital (2011) describe rich data as a "hallmark of qualitative inquiry". This is reasoned by contrasting rich qualitative data to data used in quantitative studies which Schultze and Avital (2011) describe as a thin description of phenomena using frequencies, distributions, and statistical patterns. They add that qualitative studies can include scenic details, motivations, intentions, and a web of social relationships. The term "rich data" is explained by implications of wealth and worth that the data has to produce diverse ideas and insights. (Schultze & Avital, 2011.)

Regarding different perspectives of interviews, Schultze and Avital (2011) adopt a view that mixes romantic and localist views. The romantic perspective sees interviews as a conversation which means that the interviewer can actively participate and intervene when necessary. By doing this the interviewer aims to bring alternate considerations into play rather than fish for preferred responses (Holstein & Gubrium, 1995). Further, they add that interviews are more about construction of meaning rather than stating facts. The localist perspective on the other hand adds the idea that interviews are a window on social reality (Schultze & Avital, 2011). In practice, this means that an interview gives a platform for activities such as political action or impression management. These are in turn affected by the context, like age or gender of the interviewee.

Schultze and Avital (2011) present three interviewing methods that consider the perspectives described above and their own experiences in IS research. I will describe the laddering interviewing method because it is the one I will use in this study. I will also explain the reasoning for choosing that. Schultze and Avital (2011) describe that laddering is based on using comparisons and contrasting to identify meaningful patterns in the participant's life. How this works in practice is that distinctions between elements are created by asking questions like "How are X and Y different from Z?" and meaningful connections between elements are assessed with questions like "Why is Z important?". (Schultze & Avital, 2011.)

The reason I chose laddering method for this study is particularly because my aim is to identify links between meaningful aspects of video games and features of blockchain. Additionally, Schultze and Avital (2011) note that laddering works well when trying to generate deep insights from a limited number of elements. Since interest on blockchains and especially blockchain-based games is still limited, laddering can help at identifying meaningful aspects that are overlapping from other domains.

3.4.2 The interview process

As blockchain is a novel technology there is a high chance that a general user does not know anything about it. Therefore, the demonstration will consist of letting the participant play the game and informing them on the relevant blockchain related qualities when necessary. This is in line with the perspective of providing the interviewee point of views without deliberately affecting their responses.

After playing the game, the interview itself will consist of questions that focus on the topics presented in the related Prior Research chapter. Some of the main questions that the interviews will try to answer are how the interviewees perceived blockchain related aspects like asset ownership, asset value, immutability, transparency, security, and trust. If possible, these are then connected to qualities that have positive effects on video game engagement and retention.

The structure of the interview questions follows these five topics:

1. General questions
2. What makes assets valuable
3. Asset ownership and the lack of trusted third party
4. Data on blockchain, immutable and transparent
5. Security and trust on the blockchain

Since the interviews will be semi-structured and utilize laddering, the questions depend heavily on which elements the particular interviewee finds personally meaningful. Some of the possible example questions are listed in Appendix A.

3.4.3 Data analysis

Reynolds and Gutman (1988) suggested the use of content analysis for the data they generated with laddering interviews. The key idea of their analysis was to classify the responses into three levels (attributes, consequences, and values) and study the relationships between elements on different levels. In their study, Reynolds and Gutman (1988) counted all the elements and used quantitative techniques to assess the relationships. Vaismoradi, Turunen, and Bondas (2013) noted that thematic analysis shares many similarities with content analysis except that while content analysis can make interpretations based on quantitative counts, thematic analysis focuses on purely qualitative and nuanced data. Because of the low number of interviews and the exploratory nature of this study, I will utilize thematic analysis in this study.

The data analysis will follow the six phases of conducting a thematic analysis as suggested by Terry, Hayfield, Clarke, and Braun (2017). The first step is familiarisation, which is the researcher's entry point into analysis. The purpose of this step is to engage and gain insight on the data. In practice this step includes going through the entire dataset, taking notes, and forming early and provisional analytic ideas (Terry et al., 2017). In the next phase, generating codes, the elements in the dataset are given labels/codes systematically. The codes should be generated based on how relevant the topic is for the research questions, which means that some segments of the dataset can have several codes assigned to them, while some segments might have none. The general idea of this phase is both to reduce the data (from a large mass of data to set of codes) and organize the data into patterns. (Terry et al., 2017.)

The third step of the thematic analysis is theme development which is described as “very active process of pattern formation and identification” (Terry et al., 2017). In practice the research needs to find a central idea or concept that underpins a set of codes that can be formed into a theme. Terry et al. (2017) noted that in this phase it is important to use visual aids, such as tables and figures, to illustrate the relationships between different themes and potentially identify new ones. The fourth and fifth phases are reviewing and defining themes, respectively. Terry et al. (2017) described the reviewing phase as a quality control exercise that aims to confirm that the themes work with the coded data,

dataset, and research questions. In the defining themes phase the idea is to take an interpretative role and describe what each theme exactly represents. According to Terry et al. (2017) this phase can show if there is enough depth in the theme, since there is not much to say about “thin” themes. Finally, in the sixth phase the report is produced.

4. Empirical study and findings

First this chapter describes the practical implementation of the interviews. This includes information about the timing, environment, and the participants. In the findings chapter the interview results are collected and analyzed to give an overview of the responses regarding the topics that are relevant for the study.

4.1 Conducting the empirical study

The interviews for this study were conducted in March and April in 2020. There were ten interviews in total that amounted to nearly eight hours of recording. The prerequisites for participating in the interview was an interest in blockchain or video games. Some of the interviewees were recruited based on their participation on a relevant university course, while others were recruited through personal connections. Out of the ten interviewees, three were interested in blockchain while the other seven had an interest in video games. In terms of other demographics, there was one female participants while nine were male. Three of the interviewees were studying in or had a degree from a university of applied sciences, and the other seven were studying in or had a degree from a university.

As this was a DSRM study, it was crucial to let the interviewees experience the artefact. Unfortunately, the limitations by COVID-19 made face-to-face meetings impossible for seven of the meetings. For them, the interviews were conducted using a communication software that the interviewee was comfortable with and had screen sharing capability. In these sessions, I demonstrated the usage of the artefact through screen sharing for the interviewee who was encouraged to ask questions (as opposed to playing the game themselves).

Table 2. Interview details.

Interviewee number	Topic of interest	Interview method	Interview language
#1	Blockchain	Face-to-face meeting	English
#2	Blockchain	Face-to-face meeting	English
#3	Blockchain	Online meeting	Finnish
#4	Video games	Face-to-face meeting	Finnish
#5	Video games	Online meeting	Finnish
#6	Video games	Online meeting	Finnish
#7	Video games	Online meeting	Finnish
#8	Video games	Online meeting	Finnish
#9	Video games	Online meeting	Finnish
#10	Video games	Online meeting	Finnish

Table 2 showcases the interview method and the topic of interest for each of the anonymized interviewee. It also includes a number that is used in the following chapter to give context for the comments of the individual interviewees with the abbreviation I#1, for example. While all the interviewees allowed recording, most of the interviewees were held in Finnish, so their replies had to be translated into English for this study.

4.2 Findings

The main purpose of this chapter is to report the findings by providing viewpoints towards the identified themes and sub-themes. This is done by using frequent excerpts from the interviews. The results are later used in the Discussion chapter to answer the research questions as established in the Introduction. To report the findings, I will use the same five-part structure that the interview followed. The topics as well as the themes that were identified during the data analysis are listed in the table below. This includes sub-themes that further specify the issue.

Table 3. Interview topics and corresponding themes with sub-themes.

Interview topic	Identified themes	Identified sub-themes
1. General questions	Personal relationship with video games	Personal motivation
		Emotions in video games
	Blockchain related experience	Cryptocurrencies
		Blockchain games
	Artefact related comments	Suggestions for improvement
		Retention on artefact
		Engagement on artefact
2. What makes assets valuable	What gives value to an asset?	Assets with monetary value
		Assets with non-monetary value
	Giving all assets monetary value (i.e. making them sellable and purchasable)	Financial incentive
		Unfair playing field in video games
3. Asset ownership and the lack of trusted third party	Authorities over data in a video game context	Authorities controlling exploiting
		High prerequisites for authority free environment
	Exchange through a central system as opposed to person-to-person	Convenience of centralized system
		Social aspect of person-to-person exchange
	Actual ownership of virtual assets	
4. Data on blockchain, immutable and transparent	The effects of transparency in video games and IS	Traceability and accountability
		Privacy concerns
	Third-party involvement in video games	Continued support
		Modding
5. Security and trust on the blockchain	Trust on blockchain	

Table 3 provides an overview of all the relevant themes and sub-themes discussed in the interviews. Although the results are qualitative in nature, this chapter includes some tables that showcase an overview of the answers across all interviews. These are relevant for the

most divisive themes (e.g. retention, authorities) to give a better understanding of the topic as a whole.

4.2.1 General questions

The purpose of this topic was to build some background information about the interviewee and to ask basic questions regarding the artefact. What motivates the participants to play video games as opposed to enjoying other forms of media entertainment. Nearly all of the interviewees mentioned the role of active participation. Another prevalent theme was the social aspect as mentioned by I#3, I#7, and I#10.

> *"Probably, if you want to play with your friends, it's also a sort of a social interaction."* (I#7)

Autonomy over your character was mentioned by I#4, I#6 and I#8. While I#6 emphasized the variety of environments and interacting with it, I#8 focused on the role of thinking and decision-making.

> *"Video games are great because you get to use your own brain, create things yourself, decide on the course of the events yourself, how it's going, what you're allowed to do, what you want to do. In streaming services, you can choose what to watch." (I#8)*

When asked about the significance of this autonomy, I#8 mentioned its role of alleviating stress by giving something else to think. This somewhat escapist point of view was also shared by I#3:

> *"When you put your headphones on and lights out and run Skyrim and go on an adventure, you'll get an incredible feeling. I can't get that kind of immersion from movies. […] It is a certain kind of a getaway. Not that I hate reality, but it creates an illusion of being somewhere else."* (I#3)

Regarding the emotions when playing video games, most participants noted that there exists a wide range of emotions. These included relaxation, excitement, annoyance, nostalgia, and fearfulness. I#6 provided this vivid description regarding their experience in video games:

> *"If you're looking for alleviating stress, it (the emotion) can be, for example, calmness. For example, in some role-playing game like Witcher, you can see yourself running in the virtual world and hear the wind in your ears and some music can calm the situation at the same time. It's like so versatile in terms of which emotions and senses touch you."* (I#6)

The interviewees that had their topic of interest in video games, knew little or nothing about blockchains. When they did it was mostly about Bitcoin and some were familiar with other cryptocurrencies. However, I#5 shared this personal experience regarding blockchain-related applications:

> *"Ten years ago it was pretty cool when I heard that this sort of thing is possible. Then it was kind of forgotten and then they began to be valuable. And then some completely random people started to say that "Hey, I have this blockchain idea" and it started to become annoying. Then I was like, I have heard enough*

> *of that, but still I have always thought that it is a cool idea that you can guarantee, for example, a set of numbers so that it becomes a part of a reliable sequence. As far as I know, however, I'm not utilizing it in my own life in any way."* (I#5)

The participants who were interested in blockchain had more varied background. For example, I#2 had a technical interest in the implementation of blockchain related systems and I#3 was interested in blockchain games. Regarding the social pressure to get involved with blockchain related systems, I#1 said the following:

> *"Well, with Bitcoin yes. Everybody wants money, so yeah, like, I had one friend was saying "buy, buy, buy", I actually never did. I mean I think he got some money; he sold his before it crashed a few years ago."* (I#1)

When asked which blockchain related features they would like to see in existing games, there were some ideas regarding the private key (I#5), currency conversion (I#6) and asset ownership (I#9). I#3 had the most exhaustive answer, however:

> *"I like the idea of cross-platform or cross-game related things very much. […] If we imagine, that you have a Mario game and they would release four different games where you could get this cross-stuff from each game, so that you could shuffle them around with this blockchain-like idea, I would probably buy them all. I would even allow the games to be shit, but in principle the idea that you could get everything through those means seems tempting to me. […] Another thing that I find intriguing about blockchain is that if you get things through spending a lot of effort, you get rare things and then you could sell those things for real money. I think that it is a really neat idea. Those guys who built Middle-Earth in Minecraft – they build it for 13 years – I would say that if they could now sell the Middle-Earth as a map, I think that's what they would do."* (I#3)

Regarding the artefact itself, the responses varied widely. Most gave suggestions for improving the gameplay (I#1, I#4, I#5, I#6, I#7, I#8, I#9). The biggest issue was the lack of customization. I#6 had ideas for increasing engagement through visual aids and I#7 suggested a progression system. I#7 noted that for them personally, it is really important to have long term progression and that the opponents would be on a similar level. I#5 emphasized the role of improving your cars, because of the nature of the game.

> *"Garage should be extended, and you should be able to tune and adjust your cars properly. If that was to become a real game, 60% of the experience would be just that you could say to your friend 'Look, I've got cars like these'."* (I#5)

I#2 said that the game was not interesting, but the implementation of the blockchain seemed interesting from a technical point of view. I#8 had similar thoughts as they saw the game just as a technical demonstration, but at the same time they supported the core ideas of the blockchain functionality. I#3 also noted that the genre of the game is not relevant, but the uniqueness of the virtual assets provides an interesting setting.

> *"I would play a game like that, but of course not with cars, because I think cars are the most boring thing. But if we were to say that something like Diablo would work that way, that all items are blockchain objects, it would be a really good thing. Having items in a game to be reflected in the outer world or other currency, I don't see it that it would make any game worse."* (I#8)

Although the interviewees that participated through an online meeting did not actually play the game themselves, the question "Would you play the game again?" was understood correctly as if the demonstration was their first gameplay experience. For the artefact as it was I#2, I#4, I#6, and I#10 stated that they might want to try again. This was largely attributed to the interest in generating new cars. However, I#2 and I#10 said that they would only play it a few times. The reasoning for not wanting to play the game was explained by the lack of meaningful gameplay content.

When asked if the game was engaging I#2 and I#10 said "not too much", while I#1 and I#4 said "yes". I#1's reasoning was the most straightforward. They said to be engaged because they are interacting. I#9 noted that the game is not engaging as it is, but the fundamental idea of a car race could be. I#4 and I#6 noted the competitive spirit of a car race as an engaging factor. Conversely, I#5 said that car races are boring because it resembles gambling too much, but generating things is always fun. I#8 also described generating as the engaging factor. For I#7 the engagement was through the possibility of progressing to better vehicles.

Table 4. Summary of the answers regarding playing the game again and engagement.

	I#1	**I#2**	**I#3**	**I#4**	**I#5**	**I#6**	**I#7**	**I#8**	**I#9**	**I#10**
Play again	-	Yes	-	Yes	-	Yes	No	No	No	Yes
Engaged	Yes	No	-	Yes	Partly	Partly	Partly	Partly	Partly	No

The missing answers of Table 4 are due to either the answer being too vague or not being asked at all during the interview. "Partly" means that the respondent identified some engaging aspects but would not call the game "engaging" as a whole. The extent to which the affirmative answers can be attributed to blockchain are discussed further in the Discussion chapter.

Finally, regarding the responsiveness, there were some comments about the user interface or how the gameplay worked. However, no one mentioned the slight delays of generating cars and ending games that are caused by the communication with blockchain. When discussing the delay with I#8, they noted that it can actually be used for creating suspension and excitement in the situation.

4.2.2 What makes assets valuable

The two main themes of this topic were assets/items with monetary value and non-monetary value. Each interviewee could give an example of a valuable item in a video game and some could make the distinction between an item with monetary value and an item with non-monetary value even before asked to do so. I#5 gave examples of both types of valuable items:

> *"In Player Unknown's Battlegrounds I had things that could be converted by selling to Steam-currency, and that could be used to buy any games that are sold on Steam. Additionally, in games like World of Warcraft, if you have spent a couple of years trying to find a certain item that you have a chance to get only once a week with a*

> *drop rate lower than one percent, so even if it's not in any way significant or it doesn't have monetary value, it still feels good to achieve it."* (I#5)

I#9 was able to provide insight on the nature of value itself and how items in video games are instrumental value:

> *"If we depart on this traditional discussion on values, you have these intrinsic values that a human wants to achieve. These are general foundations of a good life: There's wellbeing, peace, sufficient rest, meaningful activities, and pleasant people around you. And then there are instrumental values that are valuable because they can be used to achieve intrinsic values. Okay then, now if we go into the world of video games, and what is valuable there, I would say that we are mostly considering instrumental values. […] It (video game) is a tool for reaching a state where I can feel good – that I can feel relaxed. There, at its best, video games work really well. […] Specifically, as an instrumental value, everyone finds an item in a video game that lets you progress further or be better."* (I#9)

What I#8 essentially meant by the reply was that items in a game work as instrumental value in the game's context to advance it, while the game itself is an instrument that you can use in life to achieve intrinsic values. When asked if this instrumental value of the item in the game's context could be made exchangeable with the value of money (an instrumental value in a higher context), I#8 said the following:

> *"In principle it could be, and many people do use money to buy in game things. Personally, I rarely purchase in-game pretty much anything. I prefer that the game has its own currency that you can collect by playing the game even if it takes time. I even think that a part of the appeal, the feeling of achievement, would be lost if you use money to buy valuable in-game items."* (I#8)

The question above was one of the most divisive questions among the respondents because it could mean (at its worst) that you would be able to buy progress in the game with real money. The most critical of connecting game items to real money was I#5 who said the following:

> *"Value comes probably the most from your own effort. If you play some new game and you hear from a friend that 'Hey, that's super valuable! You can sell it and get like 10 euros from it!', but I can get 10 euros even by taking the bottles to the store, so I don't think there's anything incredible about that. At that point, it is actually just annoying to think that can I not play the game because I know that I have 10 euros worth of some bits there. Then again, if you play a game that you like otherwise, like Animal Crossing, there you happen by your own efforts to find some rare fossil that you've been waiting for a long time. Although it can't be sold to anyone, it's still valuable and it kind of increases the value of the game for myself, like: 'Yes! I have the fossil there on my shelf that I was tracking for several weeks".* (I#5)

Most people saw it as a complicated issue. I#6, I#7 and I#10 noted positives ideas like being able to sell your items after quitting the game (financial incentive), but also negatives aspects like bots and possibly an unfair playing field. The most supportive of this idea was I#3 who noted drawbacks as well:

> *"It wouldn't bother me even if we could trade genuinely valuable things. That would be fun. I can hear how my money goes down the drain. On the other hand, if*

> *everything was for sale, it could mean that using so called 'honest methods', it would be really difficult to get those items. That could be one negative drawback, that would affect people playing the game."* (I#3)

While not putting down the idea of being able to buy and sell items with real money, I#8 shares their personal reasoning for not spending money on video games, because it is a part of the challenge:

> *"For me it's important that I'm not using money on videogames because I've been through this thought process and played so many games during my life that it doesn't matter what the game is, using money in it doesn't make it better. Okay, something like PoE (Path of Exile) could be an exception, because you get so important quality of life changes like the increased stash space. Regardless, you play the game some time and if you don't use money in it, you can get an additional level of difficulty, so for example in PoE the increased stash space is a double-edged sword. It's part of the game that you don't use money in it. If you use money in it, you make it easier and it's not as good as a game. And then, a person doesn't play the game that long on average, so eventually it's money thrown in the trash. The worst thing you can do is that you buy with money the best item you can get. The game is over at that point. So, you're paying money so that you don't want to play the game anymore."* (I#8)

4.2.3 Asset ownership and the lack of trusted third party

The three main questions of this topic were: 1. Authorities over data in a video game context, 2. Exchange through a central system as opposed to person-to-person, and 3. Actual ownership of virtual assets.

The issue of authorities in video games was the most divisive. While most respondents were somewhat unsure, there were also unambiguous answers for both cases. I#3 said that it is good that there is an external authority that can take the situation under control. Conversely, I#6 wants the developers to take responsibility and not release something that can be exploited. I#6 sees that in a competitive setting the issue is that, if you do not take advantage of the possible exploit, you will fall behind and if you do and get punished by the authority, you will also risk falling behind. I#8 also prefers a setting with less authorities but notes arguments for both sides:

> *"It (a system without authorities) requires that the prerequisites and rules have been created well enough. The pros are that here the exchange happens directly and there is no third party taking its cut or supervising. Then, of course, that the exchange can happen at any time as long as there is an internet connection. The con, of course, is that because it doesn't work though banks, it can't be traced back."* ("I#8)

For the second issue, most people agreed that the option with the central system is better because it is often more convenient. However, there were also respondents who advocated for person-to-person trading. For example, I#6 gives the following example:

> *"Old Runescape didn't have Grand Exchange yet, meaning this AH (auction house) type system, so then people would gather in these trade worlds where there were thousands of people in one place shouting what they wanted to sell. Some people wanted money in return, but some were trading items for other items. It was really*

functional and extremely pleasant social event where people were gathering as if they were at marketplace." (I#6)

On top of the social aspect, I#9 notes that it would be "*a funny idea to root out free market capitalism from there (video games) as well*". I#8 sees trading as a challenge and does not want that it becomes too easy.

"Diablo 2 was such a great game, because its trading was a part of it. Humans aren't made for an easy life. A human likes that things are difficult. A human gets to solve things to get bursts of happiness through which they can live and develop. When things are made too easy, it only makes the situation worse in most cases. Okay, it can't be generalized like this, but if we're talking about just some game, no one wants to play an easy game. And if trading is one big difficult thing to do which gives an additional dimension in the game, it's only a good thing. Diablo had undoubtedly the best community for trading because it was so difficult. You got a feeling of accomplishment just by managing to complete a trade." (I#8)

Table 5. Summary of the answers regarding authority and central exchange.

	I#1	**I#2**	**I#3**	**I#4**	**I#5**	**I#6**	**I#7**	**I#8**	**I#9**	**I#10**
Authority	-	Partly against	For	Both	Both	Against	For	Mostly against	Neutral	For
Central exchange	-	Partly against	Both	-	-	Against	For	Against	Partly for	For

Table 5 collects the answers to questions of authority and central exchange regarding video game environments. "For" means support for the concept specified in the first column while "against" mean that they oppose it. "Both" means that there were equal arguments for both sides while "partly" and "mostly" refer that the arguments for one side were heavier than on the other. Neutral means that the issue was addressed without making arguments for either side.

On the third theme of this chapter, the purpose was to find out if people trust the service providers and developers with their games and game items. I#1 was concerned with the software support on mobile phones, but no one was concerned with issues regarding video game ownership. The general idea was that because there has not been any issues so far, it is expected to work in the future. I#5 was the most knowledgeable on these issues and said the following:

"For example GOG had this DRM (Digital Rights Management) free thing going on and probably still has, but it hasn't been so relevant lately. That was neat. In Nintendo's online stores – I've thought about those – they have really bad terms, but I think it's fair that from the beginning it has been stated on capital letters that 'THESE ARE NOT YOURS! YOU PAY THE PRICE OF A FULL GAME AND WE ARE ONLY LENDING THIS GAME! IF YOUR CONSOLE BREAKS, THEN SORRY ABOUT THAT!'. As long as you are aware of the terms, it's not annoying. You just have to weight it for yourself. Also, they aren't big money, a couple of dozen euros that the game costs doesn't worry me." (I#5)

Finally, there were some discussion on whether virtual and physical items are different in the sense that it feels worse to lose physical items. Most respondents had the idea that if the monetary value of the items is the same, the loss is the same. The exception to this was I#3 who said that they prefer to own physical things and mentioned to be less sad when losing virtual items. I#9 noted the challenge of tying sentimental value to virtual items but still claimed that the loss is the same.

4.2.4 Data on blockchain, immutable and transparent

There are two main themes for this chapter. The first theme examines the effects of transparency in video game data and other IS systems. The other theme is about third-party involvement in video games. Regarding transparency, I#1 brought up the distinction between transparency and public data.

> *"I think transparency is important for everything. I've been contemplating about public and private data for some time. While I believe that even if it is private it should be transparent, not all private data can be public. Transparent means that you can see a log of the actions, and public is that everybody can also see the data."* (I#1)

I#9 agreed that transparency is valuable by noting that it can improve traceability and reduce misuse. I#7 saw transparency as a good thing. I#5 was interested in the concept. I#8 weighted both good and bad sides. The rest (I#2, I#3, I#4, I#6, I#10) were mostly concerned with the possible privacy issues, although, for example I#10 did not completely shut it out:

> *"Surely it (transparent data in a system) is not better than private. If I happen to sell something, I don't want everybody to check that 'Oh, they sold that'. […] If it doesn't enable everyone to see something that a regular guy would like to keep hidden, then it's not necessarily a bad thing."* (I#10)

The topic of third-party involvement was addressed with questions regarding game support after the original developers quit and more general modding. Nearly all interviewees had positive reactions for these ideas. The exception to this was I#8. For example, when asked about the possibility to continue support, they responded:

> *"The law of supply and demand comes straight away and an old saying that you shouldn't shoot a milk producing cow. What I mean by that is that when the developers stop developing the game, it's because no one wants to fund it anymore, no one wants to buy it, it doesn't have any players."* (I#8)

The claim by I#8 was contradicted by I#6 who said the following:

> *"That (open third-party involvement) would've saved so many good game projects so far. For example, this Age of Empires Online some eight years ago was a concrete example that there was some game that was playable but it ran out of developers. There was players, sure, but no one wanted to update and continue developing the game.*" (I#6)

For the question about third-party modding, most were supportive again while I#8 gave the only critical word. The benefit of modding that I#4 presents is that mods often fix bugs that the developers have not been bothered to fix. I#6 notes that mods often renew older games with newer technology to improve graphics and playability. I#5 notes that

from a business point of view, it can be a beneficial relationship for both the developer and the community. The issue presented by I#8 goes as follows:

> *"I'm just a gamer who doesn't want to use my own thinking time to ponder these modding issues, I just play what's fun. […] It's the developers' responsibility to get the people to remain in the game and to direct us players to do the thing that makes us stay with the game."* (I#8)

The argument by I#8 means that if a game needs mods, the developers have already failed. Together with the earlier comment, the point is that it is the developer's responsibility to keep the players playing the game and if they fail at that, the game dies down and the mods will not save it.

4.2.5 Security and trust on the blockchain

The only theme of this chapter is trust on blockchain. To the question "From what you have experienced, would you say that you trust blockchain?" no one could give a direct "yes" or "no" answer. The comments that indicated most trust were "*It sounds like a solid foundation for something better*" by I#6 and "*It sounds initially trustworthy, yes*" by I#9. Most other comments set conditions like "*if it is made in the right hands*" or "*depends on the implementation*". Trust-wise the most critical comment was by I#10, who said:

> *"I would say that with my understanding still, I wouldn't (trust blockchain). […] I've played games that are based on servers and they have worked for me and everyone else, so I trust those. Maybe for me to trust blockchain, it would require that it becomes a mainstream thing and by that it's proven to be safe. […] I'm not the first guy who goes to try a new invention."* (I#10)

5. Discussion and implications

This chapter focuses on answering the research questions and addressing other implications regarding the topic of blockchains in video games. Here are the research questions again:

- RQ1: What kind of effects is the use of blockchain perceived to have regarding user retention, user engagement, and the way users value their assets?
- RQ2: Which blockchain related aspects should be considered for the future iterations of the artefact?

The research questions of this study were there to address two fundamentally different issues, although they are both crucial for the purpose of DSRM. From the DSRM perspective RQ1 effectively asks "How does the demonstration (step 4) correspond to the objectives (step 2)?". This is precisely the purpose of demonstration as defined by Peffers et al. (2007). Meanwhile, RQ2 asks "How exactly should we reiterate our artefact?", which is essential in determining how far back the DSRM process iterate. If the objectives were good, but the implementation lacking, it would be appropriate to return to the DSRM step 3; if the objectives were bad from the start, they should be redefined in the DSRM step 2.

5.1 Discussing RQ1

The first research question itself has three sub-topics: user retention, user engagement, and the way users value their assets. While qualitative research methods are suitable for the last one, the first two ones might benefit more from quantitative measures. However, it was clear from the start that just the questions "Would you play the game again?" and "Was the game engaging?" are not enough to assess the effects of blockchain on retention and engagement. Rather the goal is to identify connections between the blockchain related replies by the interviewees and the literature on engagement and retention.

The literature on user retention regarding video games, gave conflicting results at times. For example, Weber et al. (2011) showed that play diversity had a negative impact on retention on Madden NFL 11, while in the game called Jelly Splash, Drachen et al. (2016) established that high number of average stars and the low number of average moves also resulted in a negative impact. In essence, Madden players who left found the game too hard, while Jelly Splash players who left found the game too easy. I believe the difference is due to different genres and player motivations. This example shows well, how multifaceted the issue of solving player retention really is.

In the findings of this study, the most common explanation for not wanting to play the game (IkuneRacers) again was the lack of meaningful gameplay content. This is certainly in-line with the example by Drachen et al. (2016). The blockchain implementation itself could not attract the individuals who felt that the game itself is lacking. As for the participants who replied that they would like to try the game again, there is a reasonable argument to be made that the blockchain is a contributing factor to that. The literature on blockchain suggests that the tangibility of blockchain assets is one of the key characteristics of blockchain applications, and in the interviews the main reason for wanting to play the game again was the interest in generating these assets. Additionally, there were two interviewees who stated that they would want to play the game again, although it was not engaging. This could suggest that there is something interesting in the

implementation rather than in the game itself. Neither the interest in generation nor in the implementation can be attributed to blockchain with full certainty, but these are promising results that give some indication.

The table that corresponds the type of engagement with emotions and player behaviour by Bouvier et al. (2014) works well as a framework to connect the empirical research into literature (Table 1). In the model there are four types of engagement: environmental engagement, social engagement, self-engagement, and action engagement. When asked about video games generally, the elicited emotions and player behaviour for each of the engagement types were mentioned. This does not tell anything for the study in itself, but it provides the possibility to analyze the engagement type of the people who identified engaging aspects in the artefact.

The reasons for engagement as suggested by the interviews could be divided into three categories: competitive engagement (I#4, I#6, I#9), engaging generation (I#5, I#8), and engaging progression (I#7). Out of these three reasons for engagement, generation is the easiest to identify as a characteristic of blockchain because it provides a practice for genuine asset ownership. When looking at the emotions and behaviour relating to video games by I#5 and I#8, both of them identified heavily with the items listed in environmental engagement (e.g. curiosity, relaxation, exploration) and self-engagement (e.g. customizing and developing a story around the character). This makes intuitively sense. From the player's perspective generating assets is completely dependent on the environment, but they want to customize asset as soon as they can. I see, therefore, that providing genuine asset ownership through blockchain could contribute to environmental and self-engagement.

The competitive engagement could be attributed to social engagement (e.g. pleasure in social connectivity) or action engagement (e.g. mastering the game). However, I do not think that these aspects could be attributed to the blockchain implementation at this moment. The social aspect was brought up a lot and could well be focused on in future iterations, however. One good way to increase social engagement through blockchain is to enable trading.

The way users value their assets turned out to focus much more on the subjective sense on value than I anticipated when searching for prior literature. No one talked about fiat currencies, velocities or supply and demand. Still, the question of "Should all assets have monetary value?" proved to be very divisive and one that surely affects the preconception of the players when they first play the game. It is not a question that is exclusive to blockchains, but it is an issue that blockchains have an inherent advantage in addressing due to the characteristics of transparency and peer-to-peer connectivity. Our artefact could not demonstrate that one way of handling monetary issues is better than another. However, it is a topic that is so closely related to the nature of blockchains that there is room for a variety of different design solutions.

5.2 Discussing RQ2

Regarding RQ2 the interviews provided several viewpoints that were not explicitly considered as objectives in the original artefact. These are mostly related to the lack of trusted third party and the characteristics of the data on blockchain. Nearly all of the themes and sub-themes under the 3rd and 4th interview topics in Table 3 could be turned into a future research topic.

The first topic is the issue of authorities over data in a video game context. I could not find any literature on this topic that is specific to a video game context but regarding blockchains, the general idea is that you do not need authorities when you have transparency with smart contracts and consensus algorithms. However, I will emphasize the research problem as suggested by Rossi et al. (2019), how can we mitigate the risk of errors in smart contracts and ensure correct information? This was a difficult topic for the interviewees since only a few were able to give an answer advocating only for one side. Many of the interviewees identified that in an ideal scenario you would not need an external authority but were concerned if it would be possible and how would you take control of the situation without administrative power.

The smart contracts used in our artefact followed many of the principles by Bogner et al. (2016) and Tonelli et al. (2018). Their functionality was based on well-defined autonomous tasks and were therefore authority-free. What that means is that there were no privileges or exclusive rights written into the functional code of the blockchain interactions (though it would have been possible). However, we did not define an authority-free system as an objective, and we did not intend to assess it in anyway when developing the artefact. To demonstrate the usage of an authority-free system with blockchain would require two things. Firstly, the effect of the lack of authority should be able to be demonstrated, and secondly it should be able to be measured to differentiate it from the alternative.

The question of whether to use a centralized exchange system or person-to-person trading considers two other topics that are relevant for this study: value and engagement. In this case the type of engagement is social engagement. As established before, the effect of blockchain on social engagement could not be assessed based on this iteration of the artefact. However, in the case of wanting to study social engagement specifically, the manner of exchange and trading is a key issue for some people. Many of the interviewees were indifferent toward the topic or just preferred the convenience of the centralized system, but I#6 and I#8 were adamant on the significant impact person-to-person trading had on the games they played in the early 2000's. For our artefact as well, we considered the possibilities of both trading and a centralized marketplace, but neither had a high priority to be implemented for our project.

Transparency is established as one of the core benefits on blockchains and blockchain-based systems (Casino et al., 2019; Felin & Lakhani, 2018; Min et al., 2019). While the general idea of transparency guided our design, for example in the development of smart contracts, we did not make any explicit goals or objectives in terms of transparency for the artefact. The interviews provided valuable feedback on how users would feel about a system with transparent data. A lot of the interviewees raised privacy concerns while also recognizing some possible applications of transparent data. Those who saw transparency as primarily a positive feature, noted some of the same attributes than the relevant literature. For example, I#9 noted traceability of transactions which was one of the items on the list by Casino et al. (2019).

To assess transparency in a future iteration of the artefact can be potentially challenging but given how relevant the topic is for blockchain, it would be really valuable. Since there is no obvious distinction between a transparent and non-transparent system, the challenge is in presenting transparency as something that can be measured. As one of the core characteristics of blockchain it can be difficult to separate transparency from variables that depend on it. This is why it is often better to study high-level abstractions with other methods than DSR, but I think a good candidate could be an experimental setting where transparency is represented as the independent variable.

One common idea that is often brought up in the blockchain related literature is having users contribute content in the system. In video game context Min et al. (2019) call this user-created content and Curran (2019) says that blockchain enables the possibility to monetize creations. Regarding blockchain in general Felin and Lakhani (2018) present the possibility as "*Paying for contributions to intellectual property*". Ramachandran and Krishnamachari (2018) also note the possibility of monetary exchange for data and compute in IoT.

The interviews focused on two themes of user-created content that are also the two means how user-created content often occur in traditional games. These are modding and continuing support after the original developers have left the project. The findings of the interviews suggest that the possibility for this kind of third-party involvement is generally a positive feature. In addition to providing a good framework for these traditional methods of involvement, blockchains also present whole new possibilities like instant monetary exchange based on the contribution. These new methods, however, are tightly connected to other blockchain related topics like asset valuation and transparency, so when incorporating them to a new artefact, it is also important to consider the related factors.

DSR should be suitable for studying new methods of contributing user-created content because the methods are often centered around a particular design. In other words, DSR could assess how well the design fulfils the objectives in practice. Given that the interviews provided a favourable outlook on third-party involvement, incorporating the possibility for user-created content seems like a good candidate for a future iteration on the artefact.

The last topic on the interview was blockchain related security. The essential question was whether or not the interviewee trusted blockchain but there were no direct "yes" or "no" answers. In their study utilizing a modified UTAUT model Queiroz and Wamba (2019) found that neither blockchain transparency nor trust of supply chain stakeholders had a significant influence on behavioral intention to adopt blockchain. The somewhat critical replies to transparency and reserved views toward trust in this study give no reason to question the findings by Quieroz and Wamba (2019). However, I agree with many of the interviewees that concepts such as trust and transparency are primarily questions of implementation.

5.3 Further implications

Because of the iterative nature of DSRM and the second research question, a lot of implications are made explicit when addressing RQ2. For example, if the findings state that "User-created content is considered engaging", as research implications, there would be an interest to find out, for example, why and what kind of people are the most engaged. Because DSRM is an iterative process, it is an inherent part of the methodology to evaluate the findings of the demonstration and note implications that could improve the artefact.

The implications of RQ1 are related to the nature and extent of the results. Regarding player retention there was the notion that blockchain could increase player retention for people who are interested in generating assets. Since the connection between the generation interest and blockchain could not be indisputably concluded, this implies a need for more focused and controlled research where the connection is proven and not just indicated. Engagement could similarly use more quantitative research approach to

further establish the connections between types of engagement and blockchain related interests.

The answers to asset valuation in the interviews provided several implications regarding blockchain game economy. The findings established, for example, that there is no single correct answer to handle in-game economy. This is due to the other implication that people value the time and effort they put into games differently. On a more philosophical level, the answers implied that people rather think about value from a subjective rather than objective level. For example, when asked, “Why is money valuable?”, the findings suggest that the people would rather say “Because I can use it to get things” rather than “Because our society has chosen it to be the representation of common value”. Although there are a lot of implications, I will share my recommendations for future research in the Conclusions chapter.

6. Conclusions

This chapter concludes the study by summarizing the key points of the thesis, describing its limitations, and suggesting topics for future research.

6.1 Conclusions

This study utilized DSRM by Peffers et al. (2007) to demonstrate and evaluate the effects of blockchain in a video game. The game in question was IkuneRacers that was created for a university project together with a paper that addressed the first three steps of the DSRM (Paajala et al., 2020). This study continues with the same artefact and main objectives but changes the measures to qualitative interviews to better fit the scope of this setting. There were two research questions in this study, where the first aims to address the topic directly, and the second one is more relevant for the function of DSR:

- RQ1: What kind of effects is the use of blockchain perceived to have regarding user retention, user engagement, and the way users value their assets?
- RQ2: Which blockchain related aspects should be considered for the future iterations of the artefact?

There were 10 interviews in total that were performed either by face-to-face or online meetings. On face-to-face meetings the interviews included a hands-on demonstration of the artefact while on online meetings, the demonstration happened through screen sharing. The interview questions were divided into five topics and after they were conducted, the replies could be divided into 11 main themes. Out of these 11 themes formed 19 sub-themes that concentrated on the issues this study aims to address. The results of the interviews were presented as interview excerpts based on these themes. Then on the Discussion chapter the results were reflected on the literature to address the research questions.

The main findings of RQ1 addressed retention and engagement. There were indications that the blockchain related interest in generating assets or an interest on the implementation of blockchain might have contributed to the willingness of the participant to try the game again. The interviews reported a few different reasons for engagement, but the engagement types of environmental engagement and self-engagement were most associated with the blockchain related activity of asset generation. The purpose of these results is to work as initial indicators for more specified studies.

RQ2 focused on specific issues that the artefact could solve. These themes included the role of authority, exchange systems, transparency, third-party involvement, and trust. While the role of authority and transparency were the most divisive themes among the interviewees, they are also the ones that are most difficult to solve with DSR along with trust related issues. On the other hand, there were only little disagreement toward third-party involvement, and it is a domain that fits well with DSR due to the emphasis on utilizing an emerging technology. Exchange systems is another topic that could be studied with DSR. It was somewhat divisive due to two interviewees standing strong in support for person-to-person trading while others were mostly indifferent or in favour of a centralized system.

To conclude, the study gave some initial suggestions on the effects of blockchain on retention and engagement. Additionally, it provided possible steps of how this artefact

could be iterated in the future by looking at some of the blockchain related concepts from a player's point of view. Some of the themes that were identified, such as what makes a valuable asset, are not exclusive features of blockchains but one of the goals of this study was to learn to look at blockchain as a tool that can be applied in specific problems whenever they present themselves.

6.2 Limitations

The most obvious limitation of this study was that for seven out of the ten cases, I was not able to let the interviewee try the artefact themselves. While the game is simple and the demonstration through screen sharing should give a good idea, it felt that when I was able to provide the hands-on gameplay experience, it felt that the participants were more engaged in the situation. This is a notable limitation for the study when considering that one of the goals of this study was to address engagement.

I think that another issue with assessing engagement was the Finnish term I used for "engagement". I used the term "mukaansatempaava" which I found the be the most accurate but an old-fashioned word that is rarely used. While everyone understood what I meant, some thought the term was humorous and were hesitant toward using that specific term to describe the artefact.

From a methodological point of view, the main limitation of this study was the usage of only qualitative interviews to measure an aspect like retention. The literature provided good examples and insight on how to assess retention quantitatively by analysing game data. Those results could have been more accurate in terms of predicting retention. However, that would have required a lot more work on the artefact that would have been out of the scope of this study. Also, this study addressed some topics that could not have been analyzed with game data, like many of the themes in RQ2.

I noticed one limitation on the demographics of the participants in the interviews. That was the accidental overlapping of characteristics: Most of the participants who were interested in blockchain happened to speak English and happened to take part in a face-to-face interview. As this is a qualitative study that focuses on the feedback of a given person as an individual, and there were a lot personal differences anyway, this is not a significant issue. However, having very specific characteristics can work as a serious limitation when the aim is to generalize the findings.

Finally, due to our involvement in the university project course, our ability to iterate the artefact was limited. Although I cannot determine if it actually changed anything, there is always the pressure of going forward in a project. It is not a good place to turn back and iterate although that is one of the key features of DSRM.

6.3 Suggestions for future research

The possibilities for future research regarding blockchain games are endless. The purpose of RQ2 was essentially to determine how this specific artefact could be iterated for a future research. However, there are a few specific selections that I would recommend for future research that directly follow the implications of this study:

- The effects of blockchain on retention based on quantitative game data
- The effects of blockchain on different engagement types based on quantitative data by users
- DSR on blockchain related exchange systems
- DSR on systems that enable user-created content with blockchain
- Qualitative research on the role of authorities in video game environments
- Qualitative research on transparency in blockchain games

The suggestions of the topics are based on the findings of this study and identifying the specific research gaps that this study approached but could not fulfil. The suggestion of utilizing quantitative research methods in the first two suggestions are based purely on the limitations of this study. The suggestions on DSR are based on RQ2 of this study that identified those two topics as potential problems that could be solved with a DSR artefact. Lastly, the qualitative research suggestions were highly divisive topics that require more qualitative research before they could be addressed with other methods.

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Appendix A.

Example interview questions by topic:

1. General questions
    - How would you describe your relationship with video games?
    - How would you differentiate video games from other media entertainment?
    - Why are those aspects important?
    - How do you feel when playing video games?
    - How do you feel about blockchain? Do you feel the pressure to get involved?
    - What do you have to say about the blockchain game prototype?
    - Would you play the game again? Why/why not?
    - If the blockchain functionalities were implemented in an existing game you play, how would you feel about that?
    - Was the game engaging?
    - How did you feel about the responsiveness in the game?
2. What makes assets valuable
    - Have you ever considered any video game asset/item valuable?
    - How would you differentiate the value of money from that item?
    - Why is that important?
    - Do you think these could be unified?
3. Asset ownership and the lack of trusted third party
    - In the game you played, how does it make you feel that there isn't a higher authority over the assets than yourself? Explain the feelings.
    - How does the lack of middleman make you feel from a social point of view?
    - Have you ever considered who actually owns your virtual assets/items on traditional games or software platforms?
    - If so, did it concern you? Why/why not?
    - If so, how would you differentiate the concern from concern over losing something you physically own?
4. Data on blockchain, immutable and transparent
    - All of the transactions done in the game are public and your racers can be identified using your address. How do you feel about that?
    - Do you think there's value in the possibility of multiplayer interactivity after developer support ends? Why?
    - How about 3rd party modding possibilities during development? Why?
5. Security and trust on the blockchain
    - How would you describe your security concerns regarding information systems in general?
    - From what you've experienced, would you say that you trust blockchain? Why/why not?